INDUSTRIAL MINERALS — BUILDING BLOCK PROFILE

Prepared for:

Economic Development Branch
BC Ministry of Sustainable Resource Management

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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: http://srmwww.gov.bc.ca/rmd/ecdev/

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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1.0 OVERVIEW

1.1 Introduction

- Although, BC is a well known for its production of copper, gold, silver, lead, zinc and coal – BC is also an important producer of industrial minerals – BC has more than 40 active industrial mineral mines, producing some high value minerals, including magnesite, gypsum, shale, silica, white calcium carbonate, limestone and dimension stone, such as granite, marble, flagstone, etc.
- BC industrial minerals are used in the ceramic, chemical, metallurgical, construction, fertilizer and glass making industries.[2]
- The BC industrial mineral sector is characterized by a large number of producers, whose products are used primarily for intermediate uses to manufacture other products – these intermediate products are relatively diverse and often specialized in nature – companies engaged in the production of industrial minerals range in size from one or two person operations to large multinational chemical and manufacturing companies.
- Since the valued-added processing of industrial minerals is considered to be an integral component of this sector – the industrial minerals covered in this Building Block, include cement manufacturing, pulp mill lime production, drywall, drywall filler compounds, glass and glass bottle manufacturing – excluded are coal, construction aggregates, smelter gas and elemental sulphur, since these products are covered in other building blocks.

1.2 General Uses

The following lists a small sample of industrial minerals used by industry (there are many other minerals and uses which exist):[3]

Industry	Selected Industrial Minerals	Range of Uses
Construction	Limestone, dimension stone (granite, marble, flagstone, etc.), clay, diatomite, perlite, gypsum, lime, etc.	Cement manufacture, ornamental and functional stone products, brick manufacture, insulation, drywall, plaster, countertops, etc..
Metallurgical	Bauxite, silica, quartz, dolomite, magnesite, garnet, iron oxide, barite, pumice, graphite, asbestos, etc.	Feedstock, refractories, foundries, fluxing, abrasives, lubricants, friction materials, foundry sand, heat control, brakes, clutches, etc.
Chemicals	Barite, dolomite, lithium, magnesite, phosphates, bauxite, limestone, pumice, borates, zeolite, etc.	Chemical feedstock, explosives, dyes, fire retardants, wood preservatives, catalysts, cleaners, etc.,
Fertilizer and Agricultural Uses	Phosphates, borates, clays, perlite, dolomite, talc, vermiculite, peat, etc.	Chemical carriers, soil additives, animal feed, nutritional minerals, digestive enhancers, secondary micronutrients, etc.

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Industry	Selected Industrial Minerals	Range of Uses
Glass and Ceramics	Borates, silica, quartz, soda ash, kaolin, pyrophyllite, talc, bauxite, alumina, etc.	Glass, ceramic, specialty additives (glazes, enamels), fillers aerospace ceramics, electronic silicon, etc.
Fillers, Extenders And Pigments	Barite, clays, soda ash, diatomite, titanium minerals, gypsum, limestone, etc.	Coated paper, plastics, whitening pigments, plastic fillers, paint, putty and chalking fillers, sealants, adhesives, pigments, etc.,
Energy industry	Clays, magnesite, graphite, lithium, etc.	Drilling mud, refining additives, batteries, etc.
Environmental, Water Treatment	Bauxite, alumina, dolomite, limestone, zeolite, asbestos, perlite, magnesia, gypsum, pyrophyllite, etc.	Filtration (e.g., waste and effluent treatment, specialized absorbents filter media, flue gas desulphurization, cat litter, etc.
Human Consumption	Clays, dolomite, talc, magnesite, limestone magnesia, zeolites, nitrates, potash, salt, etc.	Pharmaceuticals, drugs, cosmetics, food additives, etc.

1.3 BC Industrial Minerals

- Some of the more important industrial minerals produced in BC, include limestone, cement, gypsum, dolomite, dimension stone, magnesite, pumice, silica, soapstone, talc, sulphur, clay, peat, pyrophyllite, diatomite and zeolite.
- The three largest companies in this sector are Lafarge, Lehigh, (both cement) and Owens Illinois Canada (glass) – in addition, there are over 90 other companies in this diverse sector (most are listed in Appendix 1).

1.4 Limestone

- Limestone is used to make lime and is the most significant industrial mineral produced in BC – thirteen companies produce an estimated 1.9 million tonnes/yr of lime mainly for the paper industry in BC – lime is also used in steel, base metals, pulp, glass, gas desulphurization, acid rock neutralization and cement.
- Limestone is used by the three cement plants in BC (Richmond, Delta, and Kamloops) - cement is the foundation of BC's construction industry – together the 3 plants produce 2.2 million tonnes/yr.[4]
- White limestone is used for industrial extender and filler applications, which is produced from two deposits on the Coast, and one in the Interior – about 200,000 tonnes of chemical lime is produced annually from the Marble Canyon limestone belt near Clinton.

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1.5 Gypsum

- Gypsum is mined in southeast BC and imported from Mexico, used in the manufacture of drywall in New Westminster and Surrey.
- The BC gypsum industry (production of 500,000 tonnes/yr.) is concentrated in the southeast part of the province (Canal Flats and Windermere) and supplies cement and drywall manufacturers in both Alberta and BC – BC drywall plants use about 20 percent recycled material.[5]
- BC has a number of undeveloped gypsum deposits.

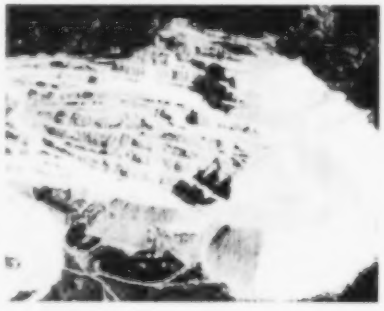
1.6 Silica

- Approximately 150,000 tonnes of glass and metal-grade silica has been produced annually from two locations in southeastern BC since 1980 – these deposits are located in a massive quartzite unit that covers a length of 100 kilometres – a similar quartzite unit is known to exist west of Prince George, but has not been developed.
- Silica is mined near Golden and is used to manufacturer glass products at Vernon – other forms of silica produced in BC are used for filtering medium for gases and water.

1.7 Magnesite

- The Mount Brussilof mine (near Radium Hotsprings) in the Rocky Mountains has operated since 1979 and produces about 80,000 tonnes magnesite annually.
- The magnesite is transported to Alberta and processed in Exshaw (near the Lafarge cement plant) into magnesium oxide, which is used to make magnesium oxide, an intermediate product that has worldwide markets.
- Magnesite can also be used to produce magnesium metal and magnesia used in many chemical and industrial applications.

Mount Brussilof Magnesite Mine
Near Radium Hot Springs



1.8 Clay

- About 40,000 tonnes/yr. of refractory clay products (high-alumina and light-weight insulation refractory bricks) are manufactured at Abbotsford – the Abbotsford refractory bricks are sold throughout the Pacific Northwest, while the insulation products are sold worldwide.
- Clay is imported into BC to make coated paper (i.e., glossy paper) at Port Alberni and Powell River (known BC clay deposits are not suitable for paper production).
- Diatomaceous clay-based industrial and domestic absorbents (e.g., kitty litter) are also produced in Kamloops, and exported to other Canadian and overseas markets.

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1.9 Other

- A fast growing industry is the quarrying, cutting and upgrading of dimension stone (e.g., granite and marble) for durable and high valued kitchen counter tops, bathrooms, floors and other construction uses.

2.0 RESOURCE SENSITIVITIES

- BC's largest industrial mineral operation and Canada's 4th largest quarry by tonnage, is the 3.5 million tonne/yr. limestone quarry on Texada Island – the quarry occupies a 100 acre site[6] – quarrying activities on Texada Island has been occurring for over 100 years and the resource sensitivities are well known.[7]
- Many of the resource sensitivities are similar to the extraction of construction aggregates, therefore the Ministry of Energy and Mines' handbook for aggregate operators may be used to manage similar potential impacts at industrial mineral quarries[8] – the most recent new quarries have addressed concerns of nearby First Nations.[9]

2.1 Sensitivities

- Depending on the remoteness of an operation, the following social and economic sensitivities may apply – the environmental sensitivities will vary as to local site conditions.

Social	Economic	Environmental
➤ Noise and vibration from blasting, crushing screening, back-up alarms ➤ Visual aesthetics. ➤ Dust from pit and trucks ➤ Heavy truck traffic safety and noise ➤ Site security and safety.	➤ First Nations rights. ➤ Truck wear on roads serving the operation. ➤ Hours of operation.	➤ Water use and discharges from surface erosion, product washing, and accidental spills. ➤ Groundwater impacts. ➤ Loss of plant cover and topsoil conservation. ➤ Fish and wildlife habitat impacts. ➤ Acid rock drainage.

- Similar to most mining operation, industrial mineral operations represent a temporary land use – when operations are completed, reclamation can restore the land to its earlier condition and in some cases create higher-valued land uses, such as for residential, commercial or recreational purposes (e.g., Butchart Gardens was once a quarry for the previous Bamberton cement plant).

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3.0 INVESTMENT REQUIREMENTS

- The total investment in industrial production and processing facilities in BC, is about $ 1.6 billion – most of this investment is represented by large cement plants in BC, owned by the large integrated multinational cement companies, such as LeHigh Northwestern and Lafarge Canada Inc.
- In addition, there are more than 90 other producers of industrial minerals in BC with a total of $400 million invested.
- Cement production is highly integrated both on the supply of raw materials and the sale of ready mix concrete – raising investment capital by larger companies, like integrated cement companies, is relatively easy.

Estimated Requirements	Units	Cement, Lime, & Limestone	Glass, Silica, Clay	Gypsum & Drywall	Granite, Marble & Slate	Other	Total
Initial investment	$ million	1,240	250	100	20	30	1,640
Capital Reinvestment	$million/yr.	62	12	5	2	2	82
Total Production	1000 mt/yr.	5,480	735	1,120	96	240	7,671
No. of Companies		24	14	4	33	9	84
No. of Locations		29	17	6	38	9	99

- For smaller industrial mineral companies, raising capital can be more difficult and one option is to privately option, sell or joint venture the property (e.g., to larger mining companies).
- Another option is to obtain public equity financing by listing a "venture class" industrial mineral company on the TSX Venture Exchange – which in the late 1990's required seed capital of about $400,000, an initial public offering capital of $850,000 and documented minimum property expenditures.[10]
- Currently there are about 900 venture class mining companies (all types) listed on the TSX Venture Exchange, representing 35 percent of the total number of companies – total market capitalization of the mining companies on the TSX Venture Exchange is about $2.7 billion.[11]

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4.0 INFRASTRUCTURE

4.1 Equipment

- Typical industrial mineral equipment includes excavators, loaders, haul trucks, crushers, screening and washing equipment, conveyor systems, stock pile areas, fuel storage and loadout equipment for tucks, barges or ships.
- Operations require power (on-site generation if remote from the power grid), natural gas, diesel fuel, water, communications, and most importantly, competitively cost transportation for accessing inputs and shipping product to the market.

Graymont Western Canada Inc.
Ts'kw'aylaxw (Pavilion) Lime Plant,

4.2 Transportation Infrastructure

- Transportation costs are an important issue with the feasibility of mineral development – whenever possible, tidewater access or established transportation routes must be used to minimize transport and port handling costs (i.e., using barges, privately owned terminals) – this is the case on Texada Island and for limestone and gypsum and clay at other terminals.
- Highway and roads are used for the transport of cement, lime, glass bottles, drywall, magnesite (to Exshaw Alberta for refining), building stone products, etc.
- Transport Canada and the BC Transportation Financing Authority's Middle Point Marine Terminal, near Campbell River is used for supplying coal for manufacturer of cement.
- Railroads are used to transport coal and elemental sulphur (e.g., from the Northeast to the Coast for export).

5.0 MARKETS

- With the inclusion of cement manufacturing, lime production at pulp mills, drywall, drywall filler compounds, glass and glass bottle manufacturing – industrial minerals production is roughly estimated to be about 7.7 million tonnes/yr. with a sales value of about $744.0 million/yr.

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Product	Producers	Sales Value	Production	Employment
		($ million)	1,000 tonnes/yr.	
Cement, Lime, Limestone, Dolomite	29	492	5,480	737
Glass, Silica, and Clay	16	123	735	583
Gypsum and Wallboard	6	71	1,120	204
Granite, Marble, Slate, Pumice	31	49	106	275
Other	8	9	240	14
Total	**90**	**744**	**7,681**	**1,813**

- With the exclusion of cement manufacturing, lime production at pulp mills, drywall, drywall filler compounds, glass and glass bottle manufacturing, industrial mineral sales is much smaller at about $50.0 million/yr.[12]
- Since the closure of the Cassiar Asbestos Mine (north of Dease Lake in Northwest BC) in the early 1990's, industrial sales values have decreased by about $50.0 to 60.0 million/yr.[13]

5.1 Cement and Gypsum

- With respect to cement, about 73 percent of BC's cement is shipped to ready mix concrete plants, 12 percent to concrete product manufacturers, 8 percent to contractors, and 4 percent to building material dealers.[14]
- The majority of the demand in the cement market occurs in the six months between May and October, which represents the peak of the annual construction season in BC[15] – Vancouver does not have a cement import terminal, unlike Seattle, San Francisco, Los Angeles and San Diego (in the US 28 percent of the cement used is imported).
- About 75 percent of gypsum imported and produced in BC is used for the manufacturer of drywall, 12 percent for cement manufacturing, and 12 percent used for agriculture and industrial processes.[16]

5.2 Dimension Stone

- There has been a recent revival of the dimension stone market – BC exports of dimension stone for building and building products stone has doubled in the past 4 years attracting the largest number of new business entrants in the industrial mineral sector. [17]
- Companies such as Margranite Industry Ltd. (produces granite products in Surrey), Garibaldi Granite (Squamish), Westcoast Granite Ltd. (Delta), Matrix Marble Co. (Southern Vancouver Island), Jade West Resources (South Surrey) are a few of the more prominent producers of dimension stone products catering to the growing high-end residential and commercial market (e.g. luxury homes, buildings, hotels in BC, Pacific Northwest, California, etc.)[18]

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5.3 Quality and Prices

- Producers of cement, chemical grade lime, silica, clay, magnetite, magnesium oxide, generally provide specific quality specifications for their products.[19]
- Dimension stone producers in BC are establishing themselves as being competitive in price and quality with other North American and offshore sources.
- Dimension stone finished to granite countertops, fireplace accessories, floor tiles, and other decorative construction products tend to return the highest prices
- The highest prices generated for industrial minerals tend to be for consumer products, such as cosmetic uses, domestic absorbents (e.g., kitty litter), agricultural supplements, etc.

6.0 EMPLOYMENT

- It is estimated that with the addition of the cement and lime industries and downstream processing, there are about 1,800 people directly employed in producing and processing industrial minerals – without cement and lime and downstream processing, primary employment in the extraction of industrial minerals is much lower, estimated to be about 500 people.[20]

	Workers
Cement, Lime, Limestone, Dolomite	737
Silica, Clay, & Zeolite	583
Gypsum and Drywall	204
Dimension Stone	275
Other Minerals	14
Direct Employment	1,813
Indirect Employment[21]	768
Induced Employment	278
Total Employment	**2,859**

- With the addition of *indirect employment* (generated by the suppliers to the primary activity) and *induced employment* (created by the respending of employment income), the total employment is estimated to be about 2,860 jobs, based on the BC Input-Output Model employment coefficients.
- The estimate of direct employment does not include the concrete products and related construction supply businesses, nor does it include companies and individuals producing stone monuments and clay pottery.

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7.0 RESOURCE CAPACITY

- BC has a large number of undeveloped industrial minerals deposits, with approximately 12,000 to 14,000 known mineral occurrences[22] - BC's exploration and development opportunities are too numerous to describe in detail (dimension stone, refractory minerals, talc, high unit value products such as silicon, magnesium metal and others). [23]
- For export industry development is focused on developing new markets for graphite, magnesite, hydromagnesite, gemstones, wollastonite, asbestos and rare earths.
- For import substitution – industry development is focusing on developing talc, clay, garnet, phosphate, gypsum, perlite, and peat.

7.1 Dimension Stone

- BC has over a 100 known dimension stone occurrences, including granite, marble, quartzite, volcanic rocks, and gneiss – in 27 of theses occurrences, dimension stone is a primary commodity.
- There are at least 5 occurrences of slate, as well as past operations, and several flagstone prospects – ornamental stone prospects also exist for rhodonite (over 40 known occurrences), some of which have been partially developed.

7.2 Refractory Minerals

- Refractory minerals such as magnesite (with potential in the Southeastern region), olivine, kyanite group aluminosilicates, graphite and silica are known in many parts of the province.
- Processing materials into specialized refractory products that are able to withstand very high temperatures consumes large quantities of electricity, in which BC has a low-cost advantage.

7.3 Other Mineral Potential

- BC has several known wollastonite deposits, including a major discovery at Zippa Mountain near the Iskut River in Northwestern BC – reserves at Zippa Mountain are in excess of 1.8 million tonnes at a grade of 80 per cent.
- Tertiary basins in BC have development potential for zeolites, bentonite, residual kaolin and perlite – garnet occurs in placer and hardrock deposits.
- Talc and white limestone deposits offer development opportunities to supply Pacific Northwest pulp and paper producers.
- Phosphate horizons in southeastern BC have also been discovered (e.g., Elkford) – in additional there are significant deposits of niobium and other rare earth elements in areas of the Rocky Mountains.
- Major limestone resources are located on the west coast of Vancouver Island in the Holbert Inlet and Quatsino Sound areas – many potential limestone resources are also known in the Interior.

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- A massive undeveloped quartzite unit is located west of Prince George, which is similar to the one supporting the silica operation near Golden.

7.4 Value-Added Potential

- Opportunities exist in BC to locate industrial mineral processing plants to produce value-added products for export and to replace imports – examples of specific opportunities include refractory products, synthetic ceramics and silicon metal.
- Other value-added opportunities include: – magnesium metal, zeolite for absorbing heavy metals, pozzolans as substitute for lime in cement manufacture, and olivine for low-emission coal power plants.

8.0 REGULATION

8.1 Provincial Approvals

- Guidance on complying with the various statues and permits that may be required for an industrial mineral project is provided in the Aggregate Operators Best Management Practices Handbook for BC.[7]
- The *Environmental Assessment Act* established BC's environmental review process, coordinated by the Environmental Assessment Office, which reviews the potential environmental, social, economic, cultural, and heritage impacts of large-scale development projects.
- Reviewable projects include metal, mineral, coal and placer mines, aggregate operations and industrial quarries (e.g., crushed rock, dimension stone), offshore mines, in addition to related processing of primary metals, minerals and mineral products and manufacturing (cement, glass, lime and asbestos).
- The BC environmental review process accommodates simultaneous review of the required permits and licences – application of permits and licences may need to incorporate detailed engineering design information, which may be difficult to justify without first approving approval-in-principle through environmental assessment approval.
- Provincial statues and regulations[24] that may apply to aggregate operations, include: the *Mines Act* (Health, Safety and Reclamation Code), *Forest Land Reserve Act*, *Forest Act*, *Range Act*, *Forest Practices Code Act*, *Soil Conservation Act*, *Agricultural Land Reserve Act*, *Land Act*, *Highway Act*, *Water Act*, *Heritage Conservation Act*, *Environmental Assessment Act*, *Fish Protection Act*, *Waste Management Act*, *Wildlife Act*.
- Most industrial minerals produced in BC are from private land – production from Crown land requires leases under the *Land Act*.
- Industrial mineral quarries are regulated under the *Mines Act* and mining permits include requirements for securities to ensure reclamation – minerals produced from Crown land are subject to a mineral tax under the *Mineral Tenure Act*.
- Provincial standards required under the *Waste Management Act* for particulate and sulfur emissions from limekilns are also important.

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8.2 Federal Approvals

- When a large-scale project triggers the *Canadian Environmental Assessment Act*, the BC and Federal governments have agreed to co-operate in a joint review process – at the end of a Federal-Provincial review, each government makes a separate decision on the project.
- Federal involvement can be triggered when projects require interprovincial or international or otherwise federal approvals, which receive federal financial assistance, or involve federal lands.
- Federal statues and regulations[25] that may apply, include: the *Fisheries Act*, *Canadian Environmental Assessment Act* (projects >1 million tonnes/yr.), the *Navigable Waters Protection Act*, *Canadian Environmental Protection Act*, *Migratory Birds Convention Act*, *Canada Wildlife Act*.

8.3 Local Approvals

- Local government regulate operations on private land through application of local bylaws that can affect emissions, soil removal, hours of operation, noise, truck transport routes, and other operating conditions (e.g., the Greater Vancouver Regional District Air Pollution Control bylaw regulating fuel use and discharges from cement kilns).
- The Minister of Municipal Affairs and the Minister of Energy and Mines approve municipal bylaws that affect mineral extraction – while mineral extraction is not a land use subject to zoning, municipal bylaws and zoning can apply operating restrictions - limitations on the duration of a land lease can affect decisions related to investment (e.g., increases perception of business risk to the creditor).
- Local bylaws[26] and other requirements that may apply at the local level, include: the *Local Government Act*, *Soil Conservation Act*, *Growth Strategies Act*, Memorandums of Agreement, Official Community Plans, Bylaws, Soil Removal Bylaws, Zoning, Subdivision & Servicing Development, Noise by-laws, Tree Retention, Commercial Vehicles, Business Licenses.

8.4 Approval Lead Time

- Timelines for the government portion of BC environmental assessment review is set out in regulation – the length of the review process depends on the complexity of the issues and could range from 12 to 30 months, or longer if a public hearing is required.
- The Aggregate Producers Association of BC has indicated that obtaining approvals for a new aggregate deposit (not unlike a large mineral deposit) can take over 5-years and cost in excess of $1,000,000.

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9.0 GOVERNMENT REVENUES

- Industrial mineral businesses are subject to fees and taxes, similar to other businesses – the main additional charges are mineral related taxes
- The value-added processing industrial minerals in BC, generates additional, employment and corporate income tax, sales and fuel taxes tax, beyond that from the mining and extraction of the minerals.
- The following table lists the various local, provincial and federal taxes and levies related to the production and transportation of industrial minerals in BC.

Municipal
- Business License Fees
- Property Taxes
- Soil Removal Fees

Provincial
- Employee Income Taxes (40k/worker, 7%)
- Crown Lands- Land Rent Fee
- Provincial Sales Tax (7.5%)
- Corporate Income Tax- (13.5%)
- WCB (0.33% wage rate)
- Fuel tax

Federal
- Employee income taxes (40k/worker, 14%)
- Employment Insurance (3.15%)
- Corporate income taxes (26.12%)
- Goods and Service Tax (7.0% on margin)
- Federal Excise Tax on fuel

10.0 INPUT-OUTPUT COEFFICIENTS

10.1 Demand Coefficients

- Since most industrial minerals are intermediate inputs (used in the production of other industrial products), it can be difficult to relate the demand for an industrial mineral to an end-use demand factor, such as population, construction starts, etc.
- Employment Coefficients[27]
- The BC Input-Output Model provides employment coefficients for some of the major components of the BC industrial mineral industry.
- As shown below, the total employment ranges from a high of 24.5 jobs per $1,000,000 in sales revenues to a low of 5.9 jobs per $1,000,000 in sales revenues.

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Employment/million sales /yr at pit	Direct	Indirect	Induced	Total
Clay Products	20.50	2.63	1.39	24.52
Abrasives	15.23	1.79	1.46	18.48
Concrete Products	10.17	4.27	1.69	16.13
Glass and Glass Products	8.21	2.99	1.21	12.41
Other Non-Metallic Ind.	6.00	2.54	0.92	9.46
Lime Industry	5.47	2.58	0.99	9.04
Cement	2.31	2.73	0.83	5.87

- Direct Employment – is the employment associated with the primary activity.
- Indirect Employment – is the employment generated within the BC economy from suppliers of the materials (goods and services) required to produce the primary product.
- Induced Employment – is generated from the suppliers paying out wages to their employees, which are then respent in the economy (net of savings and taxes).
- Total Employment – is the sum of this total economic activity, (i.e., direct and spin-off impacts) composed of three components (direct, indirect and induced).

10.2 Labor and Capital Intensity

- The employment coefficients above reflect the relative labor intensity of the industrial mineral activity – relatively high labor intensive activities include: clay, abrasive and concrete products manufacturing – medium labor intensive activities include: glass and non-metallic mineral products industries –low labor intensive activities are the manufacture of cement.
- Low labor intensity generally reflects a higher capital intensity in an industry (e.g., which generates higher output per worker and can support higher wage rates).
- Firms attempt to equalize the productivity from both capital and labor, which allows them to stay competitive and sustain operations (e.g., protect employment) during the ups and down of the commodity price cycle.

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Appendix 1: MOST INDUSTRIAL MINERALS OPERATIONS IN BC[28]

Only. Asterisk indicates a development prospect.

Cement, Lime, Limestone & Dolomite

Company	Location	Product
Lehigh Northwestern Cement Ltd.	Delta	Cement
Lafarge Canada Inc.	Richmond, Agassiz	Cement
Lafarge Canada Inc.	Kamloops	Cement
Lafarge Canada Inc.	Gillies Bay, Texada	Limestone
Lafarge Canada Inc.	Agassiz (Harper Ranch)	Limestone
Canadian Forest Products	Prince George	Lime
Norske Canada inc.	Campbell River, Crofton	Lime
Pope & Talbot Ltd.	Nanaimo	Lime
Weyerhaeuser Canada Ltd.	Kamloops	Lime
Pacific Lime Products	Prince George, Giscome	Limestone
Imasco Minerals Inc.	Port McNeil, Surrey	Limestone
Imasco Minerals	Crawford Bay, Creston	Dolomite
Imasco Minerals	Salmo, Creston	Limestone
Target Products Ltd.	Burnaby	Cement mix
Chemical Lime Co.of Canada Inc.	Langley	Lime
Graymont Western Canada Inc.	Pavillion	Lime
Eurocan Pulp & Paper Co.	Kitimat	Lime
Tembec Inc.	Crestbrook	Lime
Cariboo Pulp & Paper Ltd.	Quesnel	Lime
Abitibi Inc.	Mackenzie	Lime
Western Pulp Ltd. Partnership	Squamish	Lime
Howe Sound Pulp & Paper Ltd.	Port Mellon	Lime
Holnam West	Gillies Bay	Limestone
Ash Grove Cement Inc.	Blubber Bay, Texada	Limestone
Imperial Limestone Corp.	Vananda, Gillies Bay	Limestone
North Rock Industries	Dahl Lake	Limestone
International Marble and Stone	Crawford Creek, Lost Creek, Benson Lake	Limestone, Dolomite
I.G. Machine & Fibre Ltd.	Chilliwack	Limestone
Mighty White Dolomite	Rock Creek	Dolomite
Pacific Lime Products Ltd.	Prince George	Limestone
* Lehigh Cement	Blubber Bay, Texada	Limestone
* Lehigh Cement	Nanaimo	Limestone
* Graymont Western Canada Inc.	Port Hardy	Limestone
* Orinda Investments	Klemtu Aristazabal Is.)	Limestone
* Chilliwack Limestone Inc.	Chilliwack	Limestone
Subtotal		

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Silica and Clay

Company	Location	Product
O I Canada Inc.	Vernon	Glass bottles
Clayburn Industries Ltd.	Abbotsford, Princeton	Bricks
EEC International Ltd.	Nanaimo	Paper fillers
Highwood Resources Ltd.	Golden, Horse Creek	Silica
Bert Miller Contracting		
Lafarge Canada Inc.	Sumas	Clay
Company	Location	Product
Western Ind. Clay Prod. Ltd.	Kamloops, Princeton (Red Lake)	Fuller's Earth (Clay)
Roxul (west) Inc.	Grand Forks	Insulation
Sumas Clay Products Ltd.	Abbotsford	Fireclay
Lehigh NW Cement Ltd.	Zeballos	Silica
Lafarge Canada Ltd.	Kamloops	Silica
Pacific Abrasives Supply Inc.	Grand Forks	Abrasive grit
Canmark Int'l Resources Inc.	Princeton	Zeolite
Highwood Resources Ltd.	Cache Creek	Zeolite
Pacific Silica Ltd.	Oliver	Silica
Ironwood Clay Co.	Hunter Island, Processing in Richmond	Clay
* Zeo Tech Enviro (C2C)	Princeton, Ashcroft	Zeolite
* Whitegold Resources Corp.	Stewart	Clay
* Hat Creek?	Clinton	Clay
Subtotal		

Gypsum

Company	Location	Product
Synkoloid Co. of Canada	Surrey	Fillers
BPB Westroc Industries Ltd.	N. Westminster	Wallboard
BPB Westroc Industries Ltd.	Windermere (Elkhorn)	Gypsum
Georgia Pacific Canada Inc.	Surrey	Wallboard
Georgia Pacific Canada Inc.	Canal Flats	Gypsum
Lafarge Canada Inc.	Kamloops	Gypsum
Subtotal		

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Building Stones- Granite, Marble, Slate, Pumice

Company	Location	Product
Quadra Stone Ltd.	Vancouver, Penticton	Granite
Marble Art Canada Ltd.	Vancouver	Marble
Atlas Stone Products Ltd.	Burnaby	Cut stone
Margranite Industries Ltd.	Surrey,Penticton,Hope	Granite tile
Garibaldi Granite Gr. Ltd.	Squamish, Ashlu River	Cut granite
Matrix Marble Corporation	Cowichan Lake	Cut stone
Cowichan Terrazo & Tile	Duncan	Cut stone
Kettle Valley Stone Co.	Greenwood,Penticton	Flagstone,granite
Kootenay Stone Centre	Salmo	Flagstone
A. J. Rogac	Abbotsford	Cut stone
Great Pacific Pumice Inc.	Pemberton	Pumice
Canada Pumice Corp.	Quesnel (Nazko)	Pumice
Adera Natural Stone Ltd.	Sechelt	Granite
Marchesi Marblecraft Ltd.	Burnaby	Cut stone
Westcoast Granite Mfg.Inc	Delta	Cut granite
Marble Art Canada Ltd.	Vancouver	Cut stone
Revelstoke Flagstone Quarries Ltd.	Revelstoke	Flagstone
Pacific Granistone	Squamish	Granite
City West Development	Squamish	Granite
Granite Is. Quarries Ltd.	Lower Mainland	Cut granite
Quarry Pacific Ind. Ltd.	Kelowna, Hope	Granite
Company	Location	Product
Kellard Marble Inc.	Knight Inlet	Granite
Dunsmuir Quarries Ltd.	Nanaimo	Shale
Yoho National Stone Inc.	Sayward	Cut granite
Tsitika Stone Ind. Ltd.	Port Hardy	Cut stone
North West Granite Co.	Princeton	Granite
Mountain-Side Stone Mills	Invermere	Stone
Lumberton Mines Ltd.	Cranbrook	Feldspar
Kootenay Stone	Kootenay Stone	Flagstone
Great Pacific Pumice	Mt. Meager	Pumice
IG Machines & Fibres Ltd.	Ashcroft	Roofing granules
* Hardy Is. Granite Quarry	Zeballos	Granite
* Dome Creek Slate Co.	Prince George	Slate
* Zeo Tech Enviro Corp.	Garrison Lake	Rhyolite granite
Subtotal		

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Company	*Location*	**Product**
Baymag Mines Co. Ltd.	Radium Hot Springs	Magnesite
M-Seven Industries Inc.	Princeton	Magnetite (iron oxide)
* Cons.Vananda Gold Ltd.	Texada	Magnetite
* Fireside Minerals	Watson Lake	Barite
* W.W.C. Consulting Ltd.	Invermere	Barite
* Stralak Resources	Radium Hot Springs	Magnesium oxide
* Cassiar Resources Inc.	Cassiar	Chrysotile
* Crystal Graphite Corp.	Slocan	Graphite
Subtotal		

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SOURCES OF INFORMATION

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[1] This Building Block is one of five prepared under the *Minerals, Coal and Aggregates Building Block* heading, which covers Construction Aggregates, Industrial Minerals, Metal Mines, Coal and High Valued Opportunities.

[2] http://www.em.gov.bc.ca/dl/Mining/Exploringthefuture/IndustrialMinerals.pdf.

[3] For an example of industrial mineral wide-ranging uses, see http://www.peterharben.com/industrial_minerals_uses.htm

[4] Statistics Canada www.nrcan.gc.ca/mms/cmy/content/

[5] Statistics Canada www.nrcan.gc.ca/mms/cmy/content/

[6] The next biggest quarry in BC is the Cox Station Quarry, Mainland Sand and Gravel at 1.5 million tonnes/yr. Source: Aggregate & Roadbuilders Magazine (2002) ***Canada's 2001 Top 20 Quarries*** July/August 2002

[7] P.M. Stiles (1995) ***Holman West Materials Ltd. Limestone Quarry*** – Texada Island. Presentation for Focus on British Columbia Industrial Mineral, October 19, 1995, Vancouver, BC.

[8] BC Energy & Mines, "Aggregate Operators, Best Management Practices Handbook for British Columbia", April, 2002 www.em.gov.bc.ca/Mining/MiningStats/55AOBMPHand_pdf.htm

[9] Port Alberni project, also New Global Resources Ltd. Monteith Bay Quarry, Kyoquot, BC http://www.homegoldresources.com/pyroph/monteith.htm

[10] Mackie, James (1998)."Financing Industrial Mineral Deposits on the Vancouver Stock Exchange", Industrial Minerals in Canada Conference Preprints, Vancouver, Oct. 21-23, 1998.

[11] For information on the TSX Venture Exchange, see: http://www.tse.com/en/pdf/TSXVentureMiningSectorSheet.pdf

[12] http://www.em.gov.bc.ca/Mining/MiningStats/41indminpv1.htm

[13] BC Ministry of Energy and Mines industrial Minerals Sector Trends, http://www.em.gov.bc.ca/Mining/MiningStats/45trendindmin.htm

[14] Portland Cement Association, Skokie, IL http://www.portcement.org/index.asp.

[15] Natural Resources Canada www.nrcan.gc.ca/mms/cmy/content/17.pdf.

[16] Statistics Canada www.nrcan.gc.ca/mms/cmy/content/

[17] Statistics Canada www.nrcan.gc.ca/mms/cmy/content/

[18] See http://www.em.gov.bc.ca/Mining/Geolsurv/EconomicGeology/industrialminerals/naturalstone/industry.htm

[19] For example see Highwood Resources Ltd. www.highwood-resources.com

[20] http://www.em.gov.bc.ca/Mining/MiningStats/43employindmin.htm

[21] BC Ministry of Finance and Corporate Relations (2001), ***British Columbia Provincial Economic Multiplies and How to Use Them***. Other Non-Metal Mines, Large Aggregation. Non-metallic industries' multiplier is chosen as an "average" to apply to a range of industrial mineral categories, for which direct employment data is not available

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[22] http://www.em.gov.bc.ca/dl/Mining/Exploringthefuture/IndustrialMinerals.pdf.

[23] http://www.em.gov.bc.ca/Mining/MiningIndustry/

[24] Provincial statutes http://www.qp.gov.bc.ca/statreg/

[25] Federal statutes http://laws.justice.gc.ca/en/index/index.html

[26] Local government links http://www.civicnet.gov.bc.ca/members/municipalities/index.html

[27] BC Ministry of Finance and Corporate Relations (2001), ***British Columbia Provincial Economic Multiplies and How to Use Them.*** Large Aggregation Industries, Induced assumes "with Safety Net".

[28] BC Energy & Mines http://www.em.gov.bc.ca/Mining/MiningStats 2002. BC Ministry of Science, Competition and Enterprise, Business Taxes, Oct. 2001 www.gov.bc.ca/cse. BC Energy & Mines www.em.gov.bc.ca/Mining/Geolsurv/Publications/expl_bc/1998/ex98sw.htm, BC Energy & Mines, BC Mineral Exploration Review 2001, 2000, & 1999. and Industrial Minerals Producers list. http://www.em.gov.bc.ca/Mining/MiningIndustry/indminprods.htm

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